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Insect Pests

REPORT

OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATION OF THE GYPSY MOTH.

JANUARY, 1894.

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BOSTON:
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REPORT

OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATION OF THE GYPSY MOTH.

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Commonwealth of Massachusetts.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

I have the honor to present herewith to the General Court the report of the gypsy moth committee of the State Board of Agriculture to said Board, and the reports of the director of field work and the entomological advisor to said committee as the report of the State Board of Agriculture on the extermination of the gypsy moth; the statement of receipts and expenditures and the recommendations and suggestions contained in said reports being adopted by said Board and presented in accordance with the provisions of chapter 210, Acts of 1891, as their recommendations and suggestions.

WM. R. SESSIONS,
Secretary of the State Board of Agriculture.

Boston, Jan. 10, 1894.

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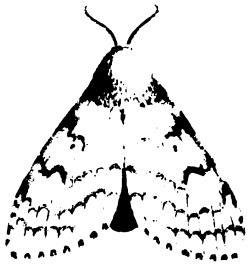

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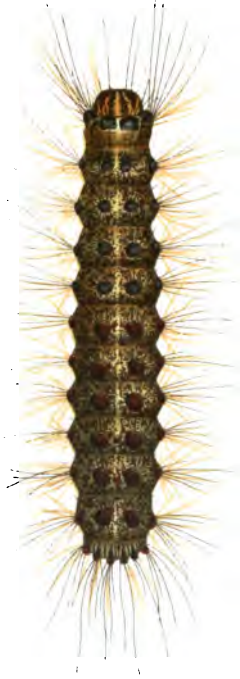

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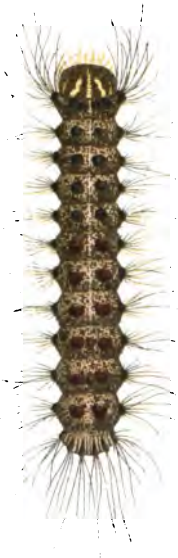

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Drawn by Joseph Bridgham.

Heliotype Printing Co. Boston.

GYPSY MOTH.

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EXPLANATION OF PLATE I.

GYPSY MOTH (Ocneria dispar, L.)

Fig. 1. — Female with the wings spread.
2. — Female with the wings folded.
3. — Male with the wings spread.
4. — Male with the wings folded.
5. — Pupa.
6. — Caterpillar. } Full grown.
7. — Caterpillar. }
8. — Cluster of eggs on bark.
9. — Several eggs enlarged.
10. — One egg greatly enlarged.

Figures 1 to 8, inclusive, natural size.

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Commonwealth of Massachusetts.

To the Massachusetts State Board of Agriculture.

In accordance with the provisions of law, the gypsy moth committee of the State Board of Agriculture presents the report of expenditures and work performed in the endeavor "to prevent the spreading and to secure the extermination of the *Ocneria dispar*, or gypsy moth, in this Commonwealth."

The presence of this insect pest was first brought to public notice in June, 1889. The Legislature of 1890 authorized the Governor to appoint a commission to take the matter in charge and appropriated $25,000 to carry on the work. Subsequently the same Legislature made an additional appropriation of the same amount. A commission was appointed and carried on the work until Feb. 15, 1891, when it was superseded by a new commission consisting of the Secretary and two members of the State Board of Agriculture. This commission commenced operations in March, 1891. An act of the Legislature approved April 17, 1891, transferred the work and all unexpended funds in the hands of the commission to the State Board of Agriculture, authorizing said Board to "exercise all the duties and powers" thus conferred upon it "by and through its Secretary and such members of said Board as it may designate and appoint" for the purpose. There remained of the amount appropriated for the work in 1890 nearly $25,000, and the Legislature of 1891 appropriated $50,000 in addition to this sum.

The task given the Board of Agriculture by the Legislature was to prevent the spreading and to secure the extermination of the gypsy moth. At that time the moth was supposed to be confined to Medford, Malden, Arlington, Everett and Chelsea, with the exception of a few colonies in North Cambridge and Somerville, one in Winchester and one in Belmont. With funds available amounting to about $75,000, the task of determining the boundaries of the region occupied by the moth was begun. Beginning at

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Medford a search was made which extended through forty-two towns and cities and resulted in finding the moth in thirty townships. This search occupied the entire season, and by it the fact was determined that the insect had spread into most of the outer towns within the few previous years.

It was proved by the experience of 1891 that spraying with known insecticides would never bring about extermination, and other means of destruction were tried. During the season the moths were reduced 90 per cent. in numbers.

In 1892 the committee asked for and received an appropriation of $75,000. During that year the infested towns were inspected as carefully as possible and fifty-three towns outside the infested region were visited, but no moths were found in any of the latter. During this season the moth was exterminated from hundreds of localities, several towns were nearly cleared of them, and the numbers of the moth were again greatly reduced.

In the summer of 1892 a means of trapping the caterpillars was put into extensive use. Bands of burlap were placed about the infested trees and those near by. As these bands were frequently visited to kill the moths found under them, new colonies were discovered, requiring further banding, and it soon became evident that the force of men would have to be increased in order properly to attend the traps and inspect the region round about them. The lessening numbers of the moth increased the work of inspection and made it more arduous. The great increase in the number of trees burlapped necessitated a larger force of men for the frequent examinations which were necessary if the largest possible advantage from the work was to be attained. These unexpected conditions greatly increased expenses and the appropriation for 1892 was found inadequate. That careful inspection of the infested territory which is so necessary to the successful completion of the labors of the Department could not be carried on in the winter of 1892–93 owing to lack of means. The few men employed were busied in cleaning up infested localities while awaiting an appropriation for the work of the season.

In January, 1893, a careful estimate was made of the amount of money which would be required to inspect the

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known infested territory and the towns immediately outside of it, and to do all the effective work possible in one year towards the extermination of the moth, and an appropriation of $165,000 was asked for. An appropriation of $100,000 was made by the Legislature and approved April 12, 1893. While the work was suspended awaiting the appropriation several of the best and most experienced men left the employ of the committee for other situations, thus greatly reducing the efficiency of the force. By reason of this delay also, at least six weeks of the best working time of the year passed by unutilized. It was evident that with an appropriation more than one-third smaller than that deemed necessary by the committee, some parts of the field would have to be (to a certain extent) neglected that other parts might be cleared. It was then decided not to attempt to exterminate the moth from the central towns in 1893, but to hold them in check there and, if possible, destroy those in the outer towns, thus reducing the area to be worked thereafter. In pursuance of this plan a large part of the force was distributed in the peripheral towns. A sufficient number of men were stationed in each town to do all that could be done to advantage towards securing there the extermination of the moth as speedily as possible.

A large amount of money was spent in inspection or searching the towns just outside the limit within which the moth had been already found. Many points in this territory had been quite as much exposed to the possible introduction of the moth as some localities where it was known to exist. It was also imperative that all the territory in the towns but little infested should be thoroughly gone over. While this work did not directly operate to reduce the number of moths, the information thus obtained was absolutely necessary to enable the director to work intelligently on the whole problem of extermination. Nearly $13,000 was expended in this work of searching. Only three colonies were found in the outside territory, and all but one of them are in close proximity to the boundaries of infested towns. The effort at extermination in the outside towns has, we believe, been quite successful, and the territory for future work other than inspection has thereby been materially reduced. The

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condition of the worst infested territory is believed to be better than it was one year ago, notwithstanding the fact that lack of funds obliged the committee to reduce the amount of work done there to the minimum.

The plan proposed last year and submitted to the Legislature, with request for an appropriation of $165,000, contemplated the employment of a sufficient force to do all that it was thought would contribute toward extermination in all the infested territory. With only about sixty per cent. of the appropriation asked for, only sixty per cent. of the work contemplated could be done, and as the plan could not be completely carried out, the season's work in many places is necessarily left in an unfinished condition. This condition will necessitate a larger expenditure next season to complete the work than would have been necessary while it was in hand the past season. The committee believe that the economical continuation of the effort to exterminate demands that all the work possible tending to the end in view should be done at once. The sooner the work is reduced to a simple work of inspection the sooner can the amount of the appropriations be safely reduced. The sum asked for last year can, we believe, be economically applied during the coming year, and we therefore recommend that $165,000 be appropriated for the work of the ensuing year.

It will be remembered that the Legislature of 1893 by resolve requested "the Senators and Representatives from the Commonwealth in the Congress of the United States to urge upon Congress the necessity of prompt and vigorous action to exterminate said pest (gypsy moth), and to use their influence to secure from Congress an appropriation of one hundred thousand dollars to assist the Commonwealth in defraying the necessary expenses of the work." A committee was sent to Washington to assist in the matter by interviewing the Secretary of Agriculture, the committees on Agriculture and Appropriations. From what this committee could learn and from recent communications from the Secretary of Agriculture, we are satisfied that no assistance can, for the present at least, be expected from the general government.

Early in the summer of 1893 five of the most experienced entomologists of the neighboring States, holding important

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positions in experiment stations or State educational institutions, were invited to examine the work of the committee and make criticisms and suggestions. For their conclusions and criticisms we refer to the report of the advising entomologist of the committee, presented as a part of this report.

Plan of Work for 1894.

First in order we place the inspection of all territory which it is thought may possibly be infested, together with the inspection of a considerable territory outside the towns known to be infested. The magnitude of this work is beyond the comprehension of the casual observer. Here is a territory of four hundred square miles that should be most carefully examined. In most parts of it every tree and shrub, as well as the ledges and loose rubbish, must be carefully examined. That gone over last year must be as carefully examined again, for assurance must be made doubly sure. If by any chance a single egg cluster has been overlooked it must be found. If neglected it will be a centre from which the pest will again spread, as a new conflagration will be likely to spread from a single neglected ember. In this territory are about 12,000 acres of woodland which may be more or less infested. It probably contains more than 5,000,000 trees, besides the undergrowth. This territory has not thus far had a tree-by-tree inspection on account of lack of money. While this woodland must remain a menace to the work until absolutely cleaned out or burned up, the enormous expense of tree-to-tree examination and the opposition of the people to destruction by fire has led the committee to consider the possibility of other plans for the woodland. Small areas here and there in the woodland are known to be infested, while others may be. The trees for some distance around these infested spots should be burlapped and carefully watched, and the remaining portion kept under surveillance for another year. Persistent efforts have been made to find a feasible plan for dealing with this forest problem. They should be continued with the hope that a plan may be found by which complete extermination may be accomplished without the expensive or drastic measures heretofore contemplated. If careful observation shall prove that the insects have only taken possession of

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small areas in different parts of the wooded territory, this problem will be much simplified.

Burlapping.

The experience of the past two years has proved to the committee that burlapping is one of the most effective methods of dealing with the gypsy moth; but to be effectual it is necessary that a sufficient number of men be employed to examine all the burlaps daily and kill all the caterpillars found under them. Lack of money has heretofore prevented a daily examination of the burlaps in the territory most centrally located and most thoroughly infested. The trees in the immediate vicinity of all known infested localities should be burlapped. This would include almost all the trees in Malden, Medford and Everett, and those in large sections of Revere, Melrose, Arlington and several other towns. The work of attending to the burlaps ceases at the close of the caterpillar season, or about the first of September. From that date the men should be put to inspecting and cleaning up known colonies until the leaves have fallen. The entire force should be employed for the remainder of the year in inspecting the whole territory. The work of past years must be verified as well as the work of the last season.

If less than the sum recommended should be appropriated, the committee would be obliged to limit the work done in the most seriously infested and most central territory to just sufficient to prevent the insects from increasing there, and employ the balance of the force that the appropriation would warrant the committee in retaining, in inspecting or searching the outside territory and cleaning up the outlying colonies. The inspection *must* be done to prevent the spreading. The amount that can be accomplished in the line of extermination depends entirely upon the size of the appropriation.

If the work of destroying the gypsy moth should now be discontinued there would probably be very little damage done for a year or two by the caterpillars. As a result of the work already done the moths are now very rare except in limited localities in the central towns of the infested district. But they are scattered here and there over a large part of this whole area, in small colonies such as started

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from the original importation by Mr. Trouvelot in Medford. Each of these colonies would gradually increase. The growth and increase of each colony would be slow at first and perhaps unnoticed. Year by year this increasing growth would result, first, in damage at the originally infested centres, and next in a gradual dissemination and extension of the moth. New colonies would be formed and in a few years' time great damage would be done in localities, as in the past. Such damage would continue and increase in spite of the efforts of individual citizens to prevent it, as was the case in Medford during the few years before 1890. Then would come the entire defoliation of trees, shrubs and all vegetation, which would result in the destruction of fruit and shade trees, the despoiling of gardens, small fruits and shrubbery. In the meantime the moths would be spreading into the woods. They would be gaining a foothold in public parks, and extending out into towns never before infested. As in the past, this condition of things would grow worse year by year. During the spring and summer months trees in our parks and pleasure grounds which are ordinarily covered and protected by their foliage would be stripped and bare, their trunks and branches a mass of crawling caterpillars. Parks, roadsides, woodlands, orchards, gardens, and, in fact, all portions of the infested area where plants or trees grow would be invaded by hosts of voracious caterpillars, which would be spinning down from the trees in great numbers upon passing vehicles and upon the persons of the inhabitants.

Experience has shown that where these caterpillars become numerous they crawl in great numbers upon and into the houses and buildings of all kinds; in fact, they intrude their disgusting presence everywhere. Wherever they become most numerous, so that the foliage disappears and food becomes scarce, the weaker are constantly dying, and the stench from their decaying bodies is nauseating. Such has been the condition where they were most numerous in the past, notwithstanding the most strenuous efforts of individuals to check them. The dissemination of the moth over this and adjoining States would probably not be so rapid as that of some other noxious insects in the past. But experience has shown that it is likely to increase very rapidly

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wherever it has obtained a foothold, and that it will become locally more destructive by reason, perhaps, of the comparative slowness of its dissemination. In the Old World it has extended its range into tropical countries, and should it extend into the Southern States it would probably be still more destructive there than here, as the number of broods produced annually usually increases in the long summer of those latitudes. A conservative estimate made by Professor Fernald places the probable annual damage which this insect would do in Massachusetts alone, if allowed to spread, at one million dollars.

To show what would be the probable condition in large areas of territory in a few years, should the work cease, the statements of residents of some of the localities which suffered most from the ravages of the gypsy moth are presented as an appendix to this report. These are selected from among sixty or more such statements in the possession of the committee.

A mass of information regarding the habits and natural history of the insect has been obtained by the advising entomologist and by the director and his assistants. Many valuable facts regarding insect life are continually being observed, and extensive experiments in the use of insecticides have been made. A great variety of plans for dealing with the gypsy moth have been tried. Various appliances have been invented for the economical and effective carrying out of these plans. A full and complete record of all these matters, comprising hundreds of closely written pages, has been preserved in the office of the committee. Our advisory entomologist recommends that this matter be carefully examined and all new scientific or practical information and discoveries sifted out, edited and printed, for the benefit of agriculturists and of entomological science. The principal entomologists of the country have repeatedly, by letter and personal appeal, urged that this be done. The committee has no authority to use the appropriation for such purposes, and would suggest that a specific appropriation of $2,000 for this purpose would enable them to have this matter arranged and edited in the proper form for printing, and would also provide means for following out some scientific experiments and observations that have been discontinued because not

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directly in the line of extermination. This material would not probably be made ready before near the end of the year, and provisions for printing it may well be deferred till next year.

The reports of Prof. C. H. Fernald, entomological advisor to the committee, and of Edward H. Forbush, director of the field work, are presented herewith as part of the report, and the committee refers to these reports for details of the work.

The following is the financial report for 1893 of the gypsy moth department of the State Board of Agriculture. It will be noticed that a large sum is reported as balance on hand. The work of the committee for the past year has been planned to avoid the annoyance caused by the exhaustion of the old appropriation before a new one is available.

Balance on hand Jan. 1, 1893,	$5,672 17
Appropriation,	100,000 00
	$105,672 17

EXPENDITURES.

Wm. R. Sessions, expenses,	$9 79
N. S. Shaler, expenses,	43 00
Francis H. Appleton, expenses,	41 43
E. W. Wood, expenses,	16 06
C. H. Fernald, expenses and remuneration,	730 16
E. H. Forbush, director, salary,	2,400 00
Book-keeper and clerks in office,	2,165 32
Travelling expenses of director and men,	1,414 24
Teaming, livery and board of director's horse,	1,888 37
Wages of men,	56,874 33
Rent of storehouse and office,	297 00
Supplies, tools and insecticides,	10,047 78
Balance on hand Jan. 1, 1894,	29,744 69
	$105,672 17

WM. R. SESSIONS,
N. S. SHALER,
FRANCIS H. APPLETON,
E. W. WOOD,
WM. H. BOWKER,

Committee of the Board of Agriculture in Charge of the Gypsy Moth Work.

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Appendix.

Copy of Statement of Mr. L. M. Clifford, 32 Myrtle Street, Medford, Mass.

In 1889 we lost three apple trees because of the caterpillars. They were stripped clean and then leaved out and bloomed again in September. The next spring they leaved out a little, but did not bear, and finally died. In 1889 the caterpillars were over everything. The house was black. They crawled inside of windows whenever they could.

Last year the gypsy-moth men got but one nest from our yard. Last year the caterpillars did no injury to the trees and they bore fairly well. They seemed, however, to have not got over the effects of being stripped two years in succession by the caterpillars and do not bear so well as formerly. One tree in particular, which formerly bore heavily, has never done so well since.

(Signed) L. M. Clifford.

Feb. 11, 1893.

Copy of Statement of Mr. J. C. Clark, Station Agent at Park Street, Medford, Mass.

I live at No. 11 Myrtle Street. The moths ruined me as regards fruit. They were the worst in 1889. Their ravages caused me to lose five nice apple trees, two cherry trees, one pear tree and five plum trees. I lost all my plum trees. One fall I got five bushels of plums from them. The caterpillars stripped these trees of every particle of vegetation. It was the caterpillars, not Paris green, that killed them, because it was before the days of the commission and the trees were not sprayed. The caterpillars did not touch the pear trees until they had eaten all the leaves on the apple trees. I had a crab-apple tree that blossomed very full that spring, but the caterpillars covered it and it died. One of the apple trees which the caterpillars killed was a beautiful Hubbardston. Some years I would get four barrels off of it to put away. All you will see of it to-day in my yard is the stump, over which we train nasturtiums. I would not have taken $100 for the tree. The spring following the ravages of the moth these trees leaved out a little, but not much, and finally died. During the summer of which I speak (1889) my currant bushes were also attacked. They were covered with caterpillars, but I saved them by sprinkling them twice a day with a solution of soap suds and kerosene. The caterpillars covered one side of my house so thickly

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Plate V.

A rock with egg clusters and pupæ of the gypsy moth upon it.
(From a photograph taken in Malden, Mass.)

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that you could not have told what kind of paint was on it. It was impossible to keep them entirely out of the house. The women had to shake their clothing when they went into the house. People used to come from other parts of Medford to Myrtle Street, just to see the ravages of the insect. The State should not drop the work of extermination under any consideration. Myrtle Street has been nicely shaded this year. Only four years ago the trees were bare. The work of the department has been very effective. The men have done great work in our section.

(Signed) J. C. CLARK.

FEB. 13, 1893.

Copy of Statement of Mrs. Wm. Belcher, 29 Myrtle Street, Medford, Mass.

Mr. Trouvelot, who is said to have introduced the gypsy moth into this country, was a next-door neighbor of ours. The caterpillars troubled us for six or eight years before they attained to their greatest destructiveness. This was in 1889. They were all over the outside of the house as well as the trees. All the foliage was eaten off our trees, the apples being attacked first and the pears next. They ate nearly every green thing in my yard, killing my rose bushes and doing much damage to the vegetables. No one who did not see them at that time can form any idea of what a pest they were. They got into the strawberry bed (although they did not eat the leaves), and I used to go out with a dust pan and brush and sweep them up by the panful. It seemed to us absolutely necessary to go out daily and make an effort to at least lessen their numbers. We killed many with boiling hot water and would then dig a hole and bury them so as to prevent a stench. Mr. Belcher was poisoned by them. While killing them upon the trees they would get upon his neck and poison it. It was impossible to stay long in the garden, for they would crawl all over one. We fought them for two or three years before the commission took hold. When they hatched out in the spring our fence would be one living mass. My sister and myself blistered the paint all off the fence with the scalding water that we poured on. When they were small it was almost impossible to keep them off one's person. It is a fact that we have scraped a quart of eggs at a time off the trees. We did the best we could to keep them down, but we could not get them all, for many would hide away and lay their eggs. To show how the caterpillars seem to strike instinctively towards a place where food may be found, my sister cried out one day, "They are marching up the street." I went to the front door, and sure enough, the street was black

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with them, coming across from our neighbor's, Mrs. Clifford's, and heading straight for our yard. They had stripped her trees, but our trees at that time were only partially eaten.

(Signed) MARY A. BELCHER.

FEB. 13, 1893.

Copy of Statement of Mr. J. P. Dill, 33 Otis Street, Medford, Mass.

In the summer of 1889, while living on Park Street, Medford, we were literally overrun with the gypsy-moth caterpillars. We had four large apple trees in our yard, which, although old, were very productive. The caterpillars first appeared on the trees in May and were at their worst in July, when they had got their growth. They ate all the leaves off the trees until it seemed as if fire had run through them. The trees finally became as leafless as in midwinter. The caterpillars began apparently by perforating the leaves and finally ate them all up. After eating the apple-tree leaves they attacked a Bartlett pear tree and completely stripped it of its leaves. We got no fruit from either the pear tree or the apple trees that year. The apple trees, indeed, we cut down later in the season, because there were holes in them, and we knew the caterpillars could never be cleaned out, and consequently did not want to suffer every year from such a pest. That summer we could have got the caterpillars out of the holes in the trees by pecks. After the caterpillars ate all the leaves off the trees they went down into the grass, where they swarmed. When the plague was the worst that summer, I do not exaggerate when I say that there was not a place on the outside of the house where you could put your hand without touching caterpillars. They crawled all over the roof and upon the fence and plank walks. We crushed them under foot on the walks. We went as little as possible out of the side door, which was on the side of the house next to the apple trees, because the caterpillars clustered so thickly on that side of the house. The front door was not quite so bad. We always tapped the screen doors when we opened them, and the monstrous great creatures would fall down, but in a minute or two would crawl up the side of the house again. When the caterpillars were the thickest on the trees we could plainly hear the noise of their nibbling at night, when all was still. It sounded like pattering of very fine raindrops. If we walked under the trees we got nothing less than a shower bath of caterpillars. We had a hammock hung between the trees that summer, but we could not use it at all. The caterpillars spun down from the trees by hundreds, even when they were of a large size. We had tarred paper around the trees, but they crawled up

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View of woodland at Cedar Hill, Swampscott, Mass., taken one year after the moths had been destroyed, the dead trees cut, and the ground burned over.

Plate IV. **(From a photograph taken in August, 1892. See plates 2 and 3.)**

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the trunks in masses and went right over the paper. The bodies of those that got stuck in the printers' ink served as a bridge for their brethren. The caterpillars were so thick on the trees that they were stuck together like cold macaroni. A little later in the season we saw literally thousands of moths fluttering in the back yard. In the fall the nests were stuck all over the street trees. Our four apple trees which we cut down because of the pest yielded the year before eleven or twelve barrels of fine Baldwin apples. I have been told that in other places in Glenwood the caterpillars even ate cabbages and other plants. In the summer of 1892 I noticed very few caterpillars.

(Signed) J. P. DILL.

MEDFORD, MASS., Feb. 11, 1893.

Copy of Statement of Mrs. S. J. Follansbee, 35 Myrtle Street, Medford, Mass.

In 1889 the walks, trees and fences in the yard and the sides of the house were covered with caterpillars. I used to sweep them up with a broom and burn them with kerosene, and in half an hour they would be just as bad as ever. There were literally pecks of them. There was not a leaf on my trees. The apple and crab-apple trees were all stripped, and the pears partly so. They even nibbled the young green pears, and I lost a good many in that way. My large cherry tree, which usually bears two bushels, was stripped clean for two years running and I got no fruit. The caterpillars ate all the young tomato vines and injured my rose bushes. The Balm of Gilead trees outside on the street were regular harboring places for the pest. Back of the house and across the railroad track was a large tract of young growth, oaks and maples. They were all stripped. The caterpillars did not leave a leaf. The trunks and branches were covered with their cocoons. The cocoons hung in bunches as big as a pint dipper. The stench in this place was very bad. This tract has since been cleared by the gypsy-moth men. Last year I had no trouble with the caterpillars. I did not see one in the yard all last summer. I picked a bushel and a half of cherries off my tree. For three years previous to 1891 my Baldwin apple tree bore no fruit on account of the ravages of the moth. It was stripped every year. In 1891 the number of caterpillars was so lessened that the trees escaped harm and bore three bushels of splendid apples. The spraying seemed to do the blossoms good. Last fall (1892) I got about two bushels off the tree.

(Signed) S. J. FOLLANSBEE.

FEB. 11, 1893.

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Copy of Statement of Mrs. I. W. Hamlin, corner of Spring and Myrtle Streets, Medford, Mass.

The gypsy-moth caterpillar became quite prominent in our neighborhood some six years ago. They were at their worst in 1889. One day in June my attention was called to some shade trees on Myrtle Street, the trunks of which were literally black with the caterpillars. Our yard was overrun with caterpillars. For six weeks a great deal of our time was devoted to killing these caterpillars and we did not have half as many as people farther down the street. When they got their growth these caterpillars were bigger than your little finger and would crawl very fast. It seemed as if they would go from here to Park Street in half an hour. We would go out in our yard time after time during the day and gather the caterpillars in dishes. Time and again I have stayed out in the yard for two hours at a time catching caterpillars. But in half an hour afterwards they seemed to be just as thick again. It was a common remark in the house, "Well, it is time to go out and make our rounds again," and then we would sally out with our pans. When the caterpillars were very small we used to kill them with hot water. The big ones we killed by pouring kerosene oil over them and burning them. Our one apple tree was stripped of its leaves for two or three years running. The trees of our next door neighbor, Mr. Randall, suffered very much. The caterpillars got into his evergreens and were so thick that they made them look black. The trees have since died. I do not know whether or not it was owing to the caterpillars. Mr. Randall was on the point of moving to Franklin, but he stayed in Medford two months that summer to fight the moths and save his trees. There were people on Myrtle Street whose geraniums and plants were eaten. Many people took much time to fight the caterpillars and killed a great many. Others would say, "What is the use?" and would do nothing. We were very glad to be relieved of the work by the appointment of the commission. The next spring we found many small ones on our fence, but we killed all that we could before they grew large and so did not suffer from them as in the preceding summer. In some other places, however, they were just as bad. Last summer I do not think I saw three caterpillars on our premises. If the State had not done something I think it would have been overrun by now.

(Signed) Mrs. I. W. Hamlin.

Feb. 13, 1893.

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Copy of Statement of Mr. Wm. B. Harmon, 55 Spring Street, Medford, Mass.

In the summer of 1890 the caterpillars destroyed all our fruit. They attacked and stripped the apple trees first and then turned their attention to the pear trees, which they also stripped. The young fruit was entirely ruined and we had nothing that fall. The trees in places were actually black with caterpillars. They would collect in great bunches and we would sweep them off with a broom. I had quite a large vegetable garden which was nearly ruined by the caterpillars. They destroyed the cucumbers and ate all the tops off the tomatoes. They also stripped some flowering plants. We could not step out of doors, either on the grass or on the walk, without crushing the caterpillars under foot. Over our front door the house was black with them. We would clear them off every morning, but in an hour it would be black again. People could not come in that way. It is no exaggeration to say that there were pecks of the caterpillars under the doorsteps and on the fence. We had both the fence and the steps split up and burned so as to deprive the pest of its harboring places. I have frequently gathered half a coal-hodful of caterpillars from the fence within a short space of time. In twenty minutes they seemed to be just as thick as ever. We burned many pecks of them in all. The next lot to ours was a vacant brush lot. It actually swarmed with caterpillars, and they came from there into our yard by thousands. Last year (1892) we saw but a few caterpillars.

(Signed) Wm. B. Harmon.

Feb. 11, 1893.

Copy of Statement of Mr. J. W. Harlow, 58 Spring Street, Medford, Mass.

We did not suffer so badly from caterpillars in 1890 as some of our neighbors, because we had no fruit trees in our yard. An oak tree in our back yard was stripped nearly bare. Our blackberry and raspberry bushes were badly eaten and we got but little fruit from them that summer. Two oaks on the street in front of our house were entirely stripped. The next year they did not leave out and were cut down. We were not troubled by the caterpillars last summer.

(Signed) J. W. Harlow.

Feb. 11, 1893.

Copy of Statement of Station Agent E. Clark, Glenwood, Medford, Mass.

When the caterpillars were thick in Medford a few years ago one would have thought that a fire had run through the gardens. The

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apple and pear trees were stripped and the fences and walks were covered with caterpillars. The work of the present department in stopping the ravages of the moth has been a success and should be continued by all means.

(Signed) E. CLARK,
Station Agent.

FEB. 11, 1893.

Copy of Statement of Mr. A. R. Bunting, Swampscott, Mass.

The gypsy-moth caterpillars were very thick in the spring of 1892 at the Marshall place, on Humphrey Street. The trees for two or three acres were stripped of their leaves. It looked as if a fire had been through them. There was no more sign of a leaf in May or June than there would be in February.

(Signed) A. R. BUNTING.

SWAMPSCOTT, February, 1893.

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Field Director's Report.

To the Committee on the Extermination of the Gypsy Moth.

Gentlemen: — It will be impossible, within the limited space allowed to this report, to describe in detail the work of the season of 1893 and its results. I shall therefore make only a brief statement of the methods employed and the results attained.

Methods.

The methods used in the extermination of the moth during the year 1893 were much the same as those of the previous year, with such modifications and additions as experience has suggested.

Eggs of the moth which had been deposited on trees, buildings and other objects were not removed, but were saturated with creosote oil or burned by a combination of dilute nitric and carbolic acids. Either of these methods insured the speedy destruction of the life of the eggs, which were less likely to be scattered about than if they were scraped from the trees.

The imported "Raupenleim" or "insect lime" was also used in banding large trees to prevent the caterpillars from climbing them, but it did not prove as effectual as in 1892, owing either to its poor quality or an unfavorable season. It was also used as a cement in filling the cavities of infested trees, thereby depriving the caterpillars of their hiding-places, and for this purpose it proved superior to anything heretofore used.

In May bands of burlap were placed around these trees as an artificial hiding-place for the caterpillars, and later a large proportion of them were found under the bands and killed. The burlaps in the outer towns were visited daily and the trees were occasionally looked over, both by the regular men and by special inspectors. This resulted in almost completely eradicating the moth from the outer towns, so that in some towns no eggs were found during the fall.

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Owing to the insufficiency of the appropriation and the consequent lack of men, the burlap on the trees in the central towns was not as often visited, but was examined fortnightly, weekly or bi-weekly, as the circumstances admitted or as immediate necessity demanded. As the effectiveness of this method depends largely on daily visits to the bands, the results were not as satisfactory as in the outer towns, but the moths were held in check and considerably reduced in numbers.

As the young caterpillars hatched and appeared in the undergrowth on the borders of woodland they were destroyed by burning over small tracts with crude oil by means of the cyclone burner, first made use of in this work in 1891. This method has proved to be certain destruction to the caterpillars if employed at the right time.

As the season advanced, traps containing artificially reared female moths were placed in the field and the males were attracted to them in considerable numbers. As many of the males emerge from the pupa before the females and are thus captured before they have an opportunity to pair, the number of fertile egg clusters may be lessened in this way at a small expense.

The experiments with insecticides made under Prof. C. H. Fernald's direction have proved conclusively that the arsenites as commonly used for spraying foliage are ineffectual with the gypsy moth. The chemical experiments made at the field director's office by Mr. F. C. Moulton, one of the inspectors employed by the committee, have resulted in the discovery of some insecticide mixtures, one of which seems to be very effective with the gypsy moth and may be useful in exterminating the pest. This consists of a mixture of an arsenite with acetate of lead and glucose in water, and apparently gives the long-sought result.* It is claimed that it is not washed off the leaves by showers, but that it is retained upon them during an entire season. It can be used in sufficient strength to kill the caterpillars of the gypsy moth without injury to the foliage. Enough spraying was done during the season to test this mixture in the field, and

* The formula most used was sodic arseniate, 29.93 per cent.; plumbic acetate, 70.07 per cent.

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it has given the best results that have yet been obtained by spraying.

The means which, though expensive, have given the best results, and have finally exterminated the moth from localities and towns, consist of a thorough, long-continued and repeated search by competent men, not only of all known infested localities, but of entire towns. The moth is now so rare in most of the infested towns that it is only by such search that it can be found, and this search must be relied upon to assure extermination.

When a colony is found all forms of the moth must be destroyed; loose bark must be scraped from the trees, the undergrowth cut and burned, all cavities which may serve for hiding places filled, and the locality carefully watched for at least two years.

This method, expensive though it may be, is sure to secure extermination.

Means of Preventing Extended Distribution.

As it was known that the moths were disseminated mainly by carriage driving and teaming from badly infested centres, plans for preventing this distribution were shaped accordingly.

Every effort was made to clear all badly infested localities and trees along the highways.

The inspection of two seasons having established with some certainty the extent of the territory infested, measures were taken to reduce its area: first, by holding the insects in check in the badly infested central towns that they might not spread further; second, by exterminating them in the outer towns which were less infested.

It was also important that an annual search should be made in the towns adjoining the infested district to ascertain whether the moths were being further disseminated.

Inspection of Towns Outside the Infested Region.

The appropriation made by the Legislature of 1893 allowed the committee to undertake the inspection of the towns in the vicinity of the infested region on a larger scale than had hitherto been possible.

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A study of the conditions which have produced isolated moth colonies has made it possible to determine what kind of localities in towns outside the known infested territory were in most danger of becoming infested during the years when the moth was abundant and spreading. In inspecting such towns particular attention has been paid to all places where vehicles from the infested region have frequently stopped, such as hotels, stores, picnic grounds, public parks, the premises of milkmen, peddlers, and of all persons who have travelled regularly in vehicles through the infested region on the way to and from Boston. By a study of the teaming from an infested town it is often possible to determine what places in other towns may have become infested by such teaming.

To illustrate: during 1889, 1890 and 1891 swill was hauled from the almshouse at Cambridge directly under trees which were then badly infested. As a probable result forty-six of the estates in towns to which the swill was transported became infested.

During the spring and summer of 1893 statistics of traffic and travel were gathered and tabulated, and two men, under the direction of Professor Shaler of the committee, were sent out in the region south of Boston with instructions to examine all localities where travel by teams centred. Their search resulted in the discovery of the moth in Franklin Park, Boston's largest public park. The moths appeared to have been established there from three to five years, but (as is usual with isolated colonies) had not spread rapidly. Much work has been done in Franklin Park by the employees of the Board, but it is doubtful whether the moths have yet been exterminated, as the tangle of ornamental vines and shrubbery which underlies the infested trees renders the result of the season's work problematical. The place must be carefully watched to secure extermination.

The railroads running north from the infested region were then followed up by these men as far as the southern portions of Maine and New Hampshire. The trees along the main lines and near stations and sidings were examined, but no moths were found. Eighteen men were also employed in a thorough inspection of the towns contiguous to the in-

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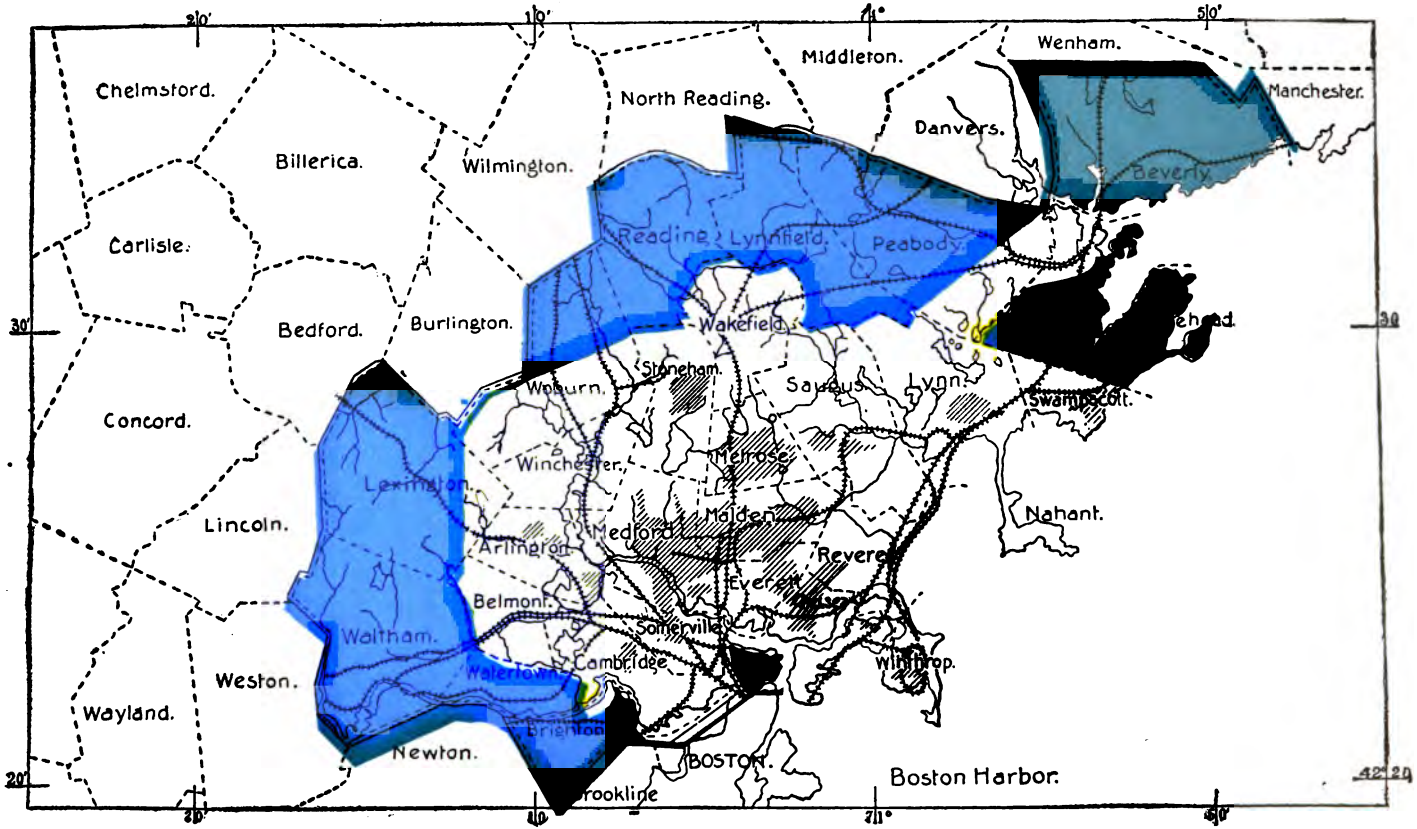

Map of the region found infested in 1891. Showing the area from which the moth has been apparently exterminated.

Territory from which the Gypsy Moth has apparently been exterminated, ■ Territory still infested Jan. 1, 1894,

Colonies found outside the known infested region in 1893.

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fested region. In the autumn, as soon as the leaves had fallen, experienced men were sent into the towns lying further west and north, with instructions to visit and inspect all estates named in the statistics obtained during the summer and all other places which during the inspection were found to have been endangered by constant teaming from the infested region. During this search two orchards were found infested in Burlington, one near the Woburn line, the other near the Lexington boundary. These, with the colony in Franklin Park and one found just over the Peabody line in Danvers, early in the season, are the only colonies known outside the region which was found infested during the search of 1891. Every visible vestige of the moth in these places was destroyed.

Every effort possible with the means at hand was made during the season to determine whether the moth had extended beyond its known limits. Many places have been reported as infested by the gypsy moth and all such reports have been investigated, with negative results.

Results of the Year's Work.

During the past year more than one hundred towns outside the infested region have been visited and either partially or wholly inspected, but in them no moths have been found. The following places named in the "list of towns infested in 1891" have been apparently cleared of the moth: Beverly, Brighton, Charlestown, Lynnfield, Marblehead, Reading, Waltham and Watertown.* (See map.) Two other towns (Burlington and Danvers) which have since been found infested, have been thoroughly searched and cleared.

While the formerly infested localities in these towns will not need to be worked as they were in 1893, each town ought to be carefully inspected at least once each year as long as the moths are known to be in the adjacent towns. Most of the known infested localities in Lexington, Peabody, Salem, Swampscott, Woburn, Winchester, Winthrop and Wakefield have been cleared, and another year's work like

* Two of these (Charlestown and Brighton) must be considered as districts as they comprise certain wards of Boston.

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the last ought to exterminate the moth from these towns. The condition of Lynn is much improved, and that of Belmont, Stoneham and Arlington considerably so. More than eight hundred colonies of the moth, situated mostly in the foregoing towns, have now been exterminated.

The other towns and cities in the infested region are in somewhat better condition than in 1892, but a much greater improvement might have been made had the appropriation been larger. The district comprising Saugus, Revere, Everett, Chelsea, East Boston, Malden, Medford, Melrose, Somerville and Cambridge was the one necessarily neglected during some parts of the year in order that the work in the other towns might be thoroughly done. This policy was unavoidable through a lack of funds sufficient to keep the whole region under constant inspection. *This necessitates a continual duplication year after year of the work done in these towns and continually defers the final extermination of the moth.*

Number of Men Employed Each Week.

Week Commencing.		Week Ending.		Number of Men.
Jan.	2,	Jan.	7,	30
	9,		14,	28
	16,		21,	28
	23,		28,	27
	29,	Feb.	4,	25
Feb.	6,		11,	24
	13,		18,	24
	20,		25,	22
	27,	Mar.	4,	25
Mar.	6,		11,	25
	13,		18,	0
	20,		25,	8
	27,	Apr.	1,	27
Apr.	3,		8,	44
	10,		15,	93
	17,		22,	115
	24,		29,	125
May	1,	May	6,	128
	8,		13,	132
	15,		20,	132
	22,		27,	132
	29,	June	3,	131
June	5,		10,	128
	12,		17,	131
	19,		24,	132

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Number of Men Employed Each Week — Concluded.

Week Commencing.		Week Ending.		Number of Men.
June	26,	July	1,	149
July	3,		8,	153
	10,		15,	154
	17,		22,	147
	24,		29,	151
	31,	Aug.	5,	146
Aug.	7,		12,	144
	14,		19,	126
	21,		26,	125
	28,	Sept.	2,	121
Sept.	4,		9,	101
	11,		16,	95
	18,		23,	93
	25,		30,	89
Oct.	2,	Oct.	7,	86
	9,		14,	85
	16,		21,	89
	23,		28,	88
	30,	Nov.	4,	88
Nov.	6,		11,	88
	13,		18,	88
	20,		25,	85
	27,	Dec.	2,	85
Dec.	4,		9,	85
	11,		16,	86
	18,		23,	85
	25,		30,	83

Work Done.

The statistics given below show mainly the results of searching and hand killing. The figures taken from the report of the work of 1892 are inserted for convenience in comparing them with those of 1893.

Trees (fruit, shade and forest) : —	1892.	1893.
Inspected,	2,109,852	4,108,494
Found to be infested with caterpillars, pupæ, moths or eggs,	108,428	44,716
Cleared of eggs,	99,989	2,068
Cemented,	12,172	4,583
Banded (insect lime),	21,251	19,453
Burlapped,	110,108	419,434
Sprayed,	7,372	5,145
Trimmed,	0	1,906

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	1892.	1893.
Trees (fruit, shade and forest) — *Concluded.*		
Scraped,	0	2,406
Cut,	395	4,055
Acres of brushland and woodland cut and burned over,	115	184
Buildings: —		
Inspected,	22,102	8,828
Found to be infested,	1,557	348
Cleared of eggs,	1,427	232
Wooden fences: —		
Inspected,	24,936	15,092
Found to be infested,	2,365	713
Cleared of eggs,	2,159	541
Stone walls: —		
Inspected,	2,213	814
Found to be infested,	672	225
Cleared of eggs,	354	93
Number of each form of the moth destroyed during the year by hand: —		
Caterpillars,	935,656	1,173,351
Pupæ,	80,021	77,029
Moths,	9,338	5,655
Hatched or infertile egg clusters,	40,954	6,868
Unhatched and probably fertile egg clusters,	99,790	46,101

It will be seen that nearly twice as many trees were inspected in 1893 as in 1892. This is accounted for by the fact that a larger number of experienced men were employed in searching the towns along the border of the infested region in 1893, and also that more time was spent during the summer of 1893 in inspecting the trees in these and the central towns.

It will be noticed that the number of trees, walls and fences found infested and the number of egg clusters found in 1893 were much less than in 1892, while the number of caterpillars destroyed was greater. In this connection it should be remembered that the number of trees burlapped during 1893 was nearly four times as great as the number burlapped in 1892, and the number of men employed during the summer of 1893 to inspect them averaged larger than the number employed in 1892. This resulted in a more frequent examination of burlaps and a consequent greater destruction of caterpillars.

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Furthermore, in 1893, the men, while engaged in inspecting the great number of burlapped trees in the worst infested towns, occasionally found and killed large numbers of caterpillars upon garden plants and shrubbery where they would otherwise have been overlooked. A few caterpillars found under a burlap sometimes furnished a clew which led to the discovery of many more near by. These greatly swelled the sum total of caterpillars destroyed, though they did not add to the number of trees infested. No accurate account of the number of caterpillars or eggs destroyed by spraying or fire could be kept.

The number of trees, fences and walls infested is in every case larger than the number cleared of eggs. This is accounted for by the fact that these objects were reported infested if any form of the moth was found upon them, but were not reported as cleared unless eggs only were found.

Non-infested Towns which have been visited by Reason of Complaints received.

Massachusetts.

Ashburnham,	Lowell,	Quincy,
Abington,	Lawrence,	Rowley,
Brookfield,	Manchester,	Rockport,
Duxbury,	Marshfield,	Sutton,
Dorchester,	Milford,	Uxbridge,
Framingham,	Newton,	Weston,
Gloucester,	North Andover,	Westborough,
Hudson,	Pepperell,	West Newbury,
Ipswich,	Princeton,	Wellesley.

Connecticut.	*Rhode Island.*	*New Hampshire.*
Glastonbury.	Providence.	Kensington.

Other Towns and Cities which have been visited and wholly or partially inspected, but have not been found infested.

Massachusetts.

Acton,	Boxford,	Groveland,
Amesbury,	Concord,	Georgetown,
Andover,	Canton,	Hamilton,
Ayer,	Dedham,	Hull,
Bedford,	Dorchester,	Hingham,
Billerica,	Essex,	Haverhill,
Brookline,	Framingham,	Ipswich,
Braintree,	Fitchburg,	Lincoln,
Bradford,	Gloucester,	Lawrence,

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Massachusetts — Concluded.

Littleton,	North Andover,	Sharon,
Lowell,	North Reading,	Shirley,
Leominster,	Quincy,	Tewksbury,
Lunenburg,	Rowley,	Topsfield,
Manchester,	Randolph,	Wenham,
Middleton,	Stoughton,	Wilmington,
Milton,	Salisbury,	Wayland,
Newton,	Springfield,	Weston,
Newbury,	Sudbury,	Wellesley.
Newburyport,		

Stations in Maine and New Hampshire visited in inspecting along the Railways.

Maine.

Agamenticus,	Eliot,	Portland,
Biddeford,	Kennebunkport,	Saco,
Berwick,	Kittery,	Scarborough,
Conway Junction,	Kennebunk,	Wells.

New Hampshire.

Atkinson,	Madbury,	Rye Beach,
Durham,	Newmarket,	Rollinsford,
Dover,	Newton Junction,	Salmon Falls,
Exeter,	Portsmouth,	Seabrook,
Greenland,	Powow River,	State Line,
Hampton,	Plaistow,	Westville.
Kingston,		

List of Places formerly infested from which the Moth has been apparently exterminated.

Beverly,	Danvers,	Reading,
Brighton	Lynnfield,	Waltham,
Burlington,	Marblehead,	Watertown.
Charlestown,		

List of Cities and Towns still infested.

Arlington,	Malden,	Saugus,
Belmont,	Medford,	Somerville,
Boston,	Melrose,	Stoneham,
Cambridge,	Peabody,	Wakefield,
Chelsea,	Revere,	Winchester,
Everett,	Salem,	Winthrop,
Lexington,	Swampscott,	Woburn.
Lynn,		

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Why the Moth has not yet been exterminated.

First. It had been established here for over twenty years; had spread over thirty townships, and had obtained a strong foothold before any organized attempt was made to check it. These facts alone rendered its extermination, even under the most favorable circumstances, a matter of several years' time.

Second. As the extent of its dissemination was not at first accurately determined, the appropriation made by the Legislature proved utterly inadequate.

The appropriations of 1890 and 1891 were made with the understanding that the moth had been found in a few towns only and was confined to cultivated lands. Though this understanding was based on the most reliable information that could then be obtained, later search by the agents of the Board of Agriculture proved that the moth had invaded many towns, and in several of them had penetrated the forested lands.

Third. As the difficulty of extermination has not been and is not now generally appreciated, the expense of the undertaking has been underestimated and the appropriation of 1893 was insufficient.

The Difficulty and Expense of Extermination.

To appreciate the difficulties and uncertainties connected with an attempt to exterminate an imported insect, it must be borne in mind that insects when transported to a new country frequently change their habits to such an extent that new methods of dealing with them must be devised; also, that very little accurate information of the life history and habits of the gypsy moth in this country had been recorded.

It was impossible at first to secure experienced men for the work. It was necessary to select and train the number of men required. And although the advice of some of the most distinguished entomologists of this country was sought, the methods recommended by them as being effectual with native insects proved inadequate for the extermination of the gypsy moth.

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Though every effort was made in 1891 to exterminate the moth from the region most infested, the search of 1892 gave abundant evidence of the impossibility of exterminating it in one year's time. Although the greater part of the eggs had been destroyed, caterpillars were found in most parts of the infested territory. It was seen that eggs scattered on the ground and exposed to the elements during winter produced some caterpillars. The eggs are thus frequently scattered by the wind; by ice forming on the trees; by people picking fruit or trimming and cutting down trees; and by various other causes. The female moth often drops a few eggs upon the ground or in the crevices of the bark where they are likely to escape the most thorough search. Such eggs are often fertile. Young caterpillars have been seen to come forth from them in the spring. Though many colonies nevertheless have been exterminated by destroying the eggs, it will be seen how difficult, nay, even impossible, is complete extermination over a large area by this method alone.

It is now a well-known fact that spraying with the arsenical insecticides commonly used is only partially effective with this insect, and such was the prejudice prevailing against this method in some of the infested towns that people frequently washed the trees and shrubbery with water from the garden hose and so neutralized the effect of the spraying.

Bands of insect lime merely prevent the caterpillars from climbing trees which have been first cleared of eggs. But they frequently find means to ascend the trees in spite of the lime bands, and if driven from the trees they will betake themselves to the gardens and shrubbery.

While the burlap bands afford a means of assembling the caterpillars so that they may be easily killed, they cannot all be disposed of in this way, as there seems to be an increasing tendency to avoid the "burlaps," possibly due to natural selection.

What Means of Extermination then remain?

There are certainly two, and possibly three, means which have accomplished the object sought wherever they have been thoroughly applied. Fire can be used either to destroy the eggs of the moth, to kill the caterpillars or to starve

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them by burning all near-by vegetation on which they feed. This method is feasible only on waste lands.

A thorough, scientifically conducted search for and destruction of eggs, supplemented by burlapping and hand killing, is the only method yet known that can be implicitly relied upon to secure extermination where fire cannot be used.

Work of this kind is necessarily very expensive and the result is uncertain unless it is followed for several years. Many localities are being cleared in this way each year. This sort of work requires experienced and expert men who are intimately acquainted with the localities in which they work and the distribution and history of the moth therein.

If all trees and plants in and near each isolated moth colony could be sprayed with an insecticide which would surely and quickly kill all feeding caterpillars without injury to the foliage, it would be the best plan to pursue in the towns least infested. Such an insecticide seems to have been found. If, however, it should fail to be as effectual in the field as is expected, further chemical experiments must be made to find an effective insecticide.

The usual plan of fighting noxious insects is to wait until they begin to do visible damage, and then take means to check them. But with extermination as the object it is a grave error to wait until the moths have become apparent anywhere to common observation — until they have begun to do damage, as in the past, and have scattered to a distance from the worst infested spots. They must instead be at once searched for, found and destroyed. Thousands of infested trees have been marked during the past season on each of which only a single caterpillar, pupa, or egg cluster was found. But these single forms of the moth must be found and destroyed if the insect is to be exterminated.

The statute under which the committee is appointed calls for extermination. The cost of extermination is great. It certainly costs a vast deal more to search for the last egg cluster and the last caterpillar or moth than it would to destroy the majority of them and thus prevent both dissemination and damage for the time being. But if larger sums of money than those already appropriated can be secured,

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and the extermination of the moth can be accomplished, an expense will be stopped which must otherwise be constantly increasing and which must be borne annually for an indefinite period either by the State or by all residents of the country over which the moth would extend its constantly widening range.

Encouraging progress toward extermination has already been made with manifestly insufficient funds and in the face of many obstacles. The numbers of the moth have been so reduced that no material damage has been done by it during the past two years. It has been exterminated first from single trees, then from orchards, woodlands and entire towns. More than eight hundred infested localities have been entirely freed of its presence. This work was begun on the borders of the infested region and has progressed toward the centre until the moth appears now to have been exterminated from more than one-third of the region infested in 1891.

Respectfully submitted,

E. H. FORBUSH.

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Plate VI.

Egg clusters and pupæ of the gypsy moth.
(From a photograph taken in Malden, Mass.)

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Entomologist's Report.

To the Committee on the Gypsy Moth.

Gentlemen: — The work of exterminating the gypsy moth has been carried on during the past year with great vigor and success. I have made as frequent visits to the field of operations as my other duties permitted, and have kept in close touch with all the work.

By your direction I invited six of our most prominent entomologists to visit the infested territory, inspect the work and give their impressions and advice. Professor Comstock was unable to do this, but the other gentlemen accepted the invitation, visited the infested region in June, and thoroughly inspected the work in all its departments. I give the following extracts from their reports.

Professor Packard of Brown University says, "I have no adverse criticisms to make. It seems to me that the work is practical and thorough throughout. I saw nothing to find fault with, but much to commend. The new and ingenious devices for spraying, and, in other ways, destroying the eggs and worms interested me very much."

Professor Weed of the New Hampshire Agricultural College says, in his report, "The results already reached seem to me remarkable, and I was greatly surprised at the scarcity of gypsy caterpillars. I found that a series of experiments with remedies was being conducted under the most careful conditions; in fact I have never seen a series of similar experiments carried on in so large a scale, in so thoroughly scientific a manner."

Dr. Fernald of the Pennsylvania State College says, "A careful consideration of the methods used and of the results already obtained has convinced me that the extermination of the gypsy moth is not only possible but certain, if the work be prosecuted for a sufficient length of time. It is to be feared, however, that the apparent disappearance of the moth may lead the Legislature into the error of abolishing the work at a time when it shows the fewest results, but will, in reality, be the most valuable; in fact, would be absolutely necessary to ensure the prevention of some future invasion."

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Professor Smith of Rutgers College, after speaking in terms of commendation of the work, experiments, etc., says, "The force under the direction of Mr. Forbush has accomplished wonders, and I feel that there is very good reason for the belief that the gypsy moth can be exterminated, provided the means are furnished by the Legislature of Massachusetts, in as liberal a spirit at least as past appropriations have been made."

Professor Lintner, State Entomologist of New York, says, "I was not prepared to see that such progress had been made towards the extermination of the notorious gypsy moth. It was a surprise to me that, in the brief space of three years, the fearful ravages of the insect, as described to me and as pictured in photographs, could have been reduced to such an extent that to the ordinary observer no indication of its presence was visible, and that in a ride of an entire day through several of the infested towns, including a visit to localities that had been frightfully scourged, not a single example of the caterpillar was found by me, although diligent search for it was made. How a work of such magnitude, extending over so large a territory, could have been accomplished was a wonder and an enigma to me, until I became acquainted with the means by which it had been brought about. I trust that your Legislature will see the wisdom of continuing the work under suitable appropriations, until the extermination of the insect has been attained."

The above named gentlemen all expressed themselves very strongly in favor of the continuation of the work to the complete extermination of this insect, which is sure to prove so exceedingly destructive if it be left to itself.

It has been a greater surprise to me than to any one else, perhaps, to see what has been accomplished from the first; for few persons, if any, have followed and watched the work more closely than I have been able to do from the time the presence of the insects was reported. Only those who have thus carefully and frequently inspected the work can fully realize how much has been accomplished.

During the past season I have had a large number of experiments performed with various insecticides, for the purpose of determining what substances would prove the most

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successful in destroying the caterpillars, and at the same time the least injurious to the foliage. Experiments with Paris green, repeated each year since the work began, have shown that this substance, in any proportion that will not greatly injure the foliage, will not destroy all the caterpillars when small and only a small proportion of them when more than half grown.

The insecticides used in the experiments referred to were Paris green, Paris green and lime, London purple and acetate of lead, Malden white, Moulton's insectine, woodbine kennel mixture, antinonnin, gypsine. This last substance proved by far the most satisfactory, since it was in no way injurious to the foliage even when used in so large a proportion as twenty-five pounds to one hundred and fifty gallons of water, and it also proved very destructive to the caterpillars. Antinonnin was not received until late in the season, and therefore the experiments with it were not conclusive. There can be no doubt that gypsine will prove far more valuable in destroying the gypsy moth than any of the insecticides in common use, because it can be used in such large proportions as to prove fatal to the insect.

In my report last year I gave a list of four species of insects found destroying the eggs of the gypsy moth, and nine species of true parasites living within and destroying the caterpillars. To this number should be added *Pimpla pedalis* Say., which was omitted from the list last year, by an oversight and *Pimpla tenuicornis* Cress., which has been bred from the gypsy moth this year, thus making a list of eleven different species of true parasites which live within the caterpillar, but which do not emerge until after it changes to a pupa and is dead. There can be no doubt that still other species will be found to attack the gypsy moth in this country. Mr. L. O. Howard, a most excellent authority in such matters, estimates that there are only fourteen undoubted hymenopterous primary parasites on the gypsy moth in Europe, one of which, *Apanteles glomeratus*, already occurs in this country, but it has not as yet been observed preying on the gypsy moth.

Respectfully submitted,

C. H. FERNALD.

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